

Gensym 2014 Users Group Conference

Hotel Du Louvre, Place André Malraux, Paris, France

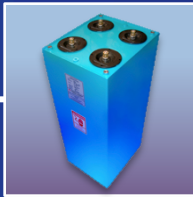
2 June 2014

ISHM G2 Toolkit

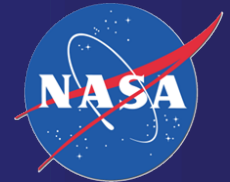


Kim Wilkins, General Atomics, San Diego, CA, USA.

Fernando Figueroa, NASA Stennis Space Center, MS, USA.



Presented by: Kim Wilkins, San Diego, California
kim.wilkins@ga.com Cell 619 227 7050
Senior Software Engineer



Overview – ISHM Toolkit

Integrated System Health Management

- **Toolkit for developing ISHM and Control applications**
- **Libraries of objects and methods to develop domain maps (models), such as electrical, computing, mechanical, thermal, hydraulic**
- **Libraries of fault trees (using Symcure)**
- **Built-in real time and simulator engines**
- **Built-in monitor creation, plotting, analysis**
- **Built-in sequencer to command and control via OPC to devices like PLCs**
- **User Interface is multiple Telewindows NG**

Application Example

- **GA and NASA have jointly developed this toolkit originally at Stennis Space Center and currently used at the Kennedy Space Center in the Cryogenic Testbed Laboratory**
- **This is a testing facility for rocket refueling, one goal is to improve upon Shuttle refueling operations**
- **Allen Bradley PLC controlling valves, pumps, sensors**

NASA Cryo Test Facility



What liquid Nitrogen does at -320 F

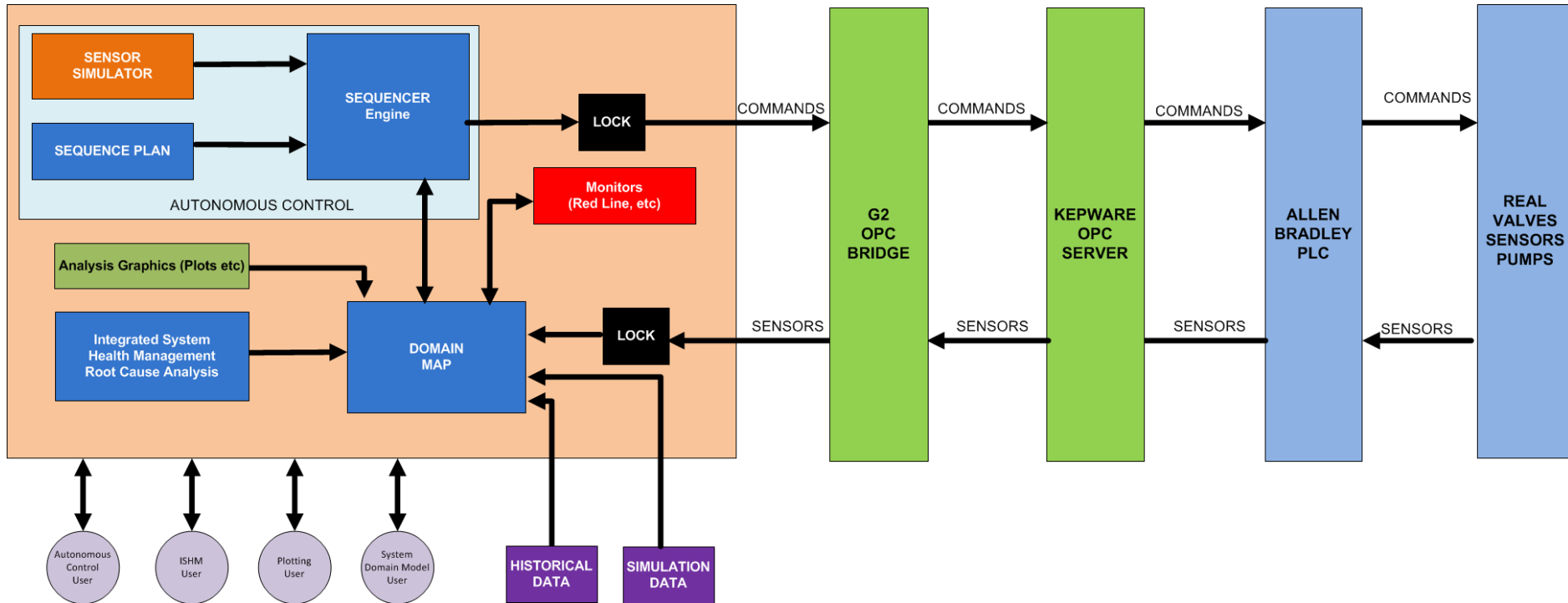


User Interface



Architecture

Autonomous Control and ISHM



Operational Modes

REAL TIME

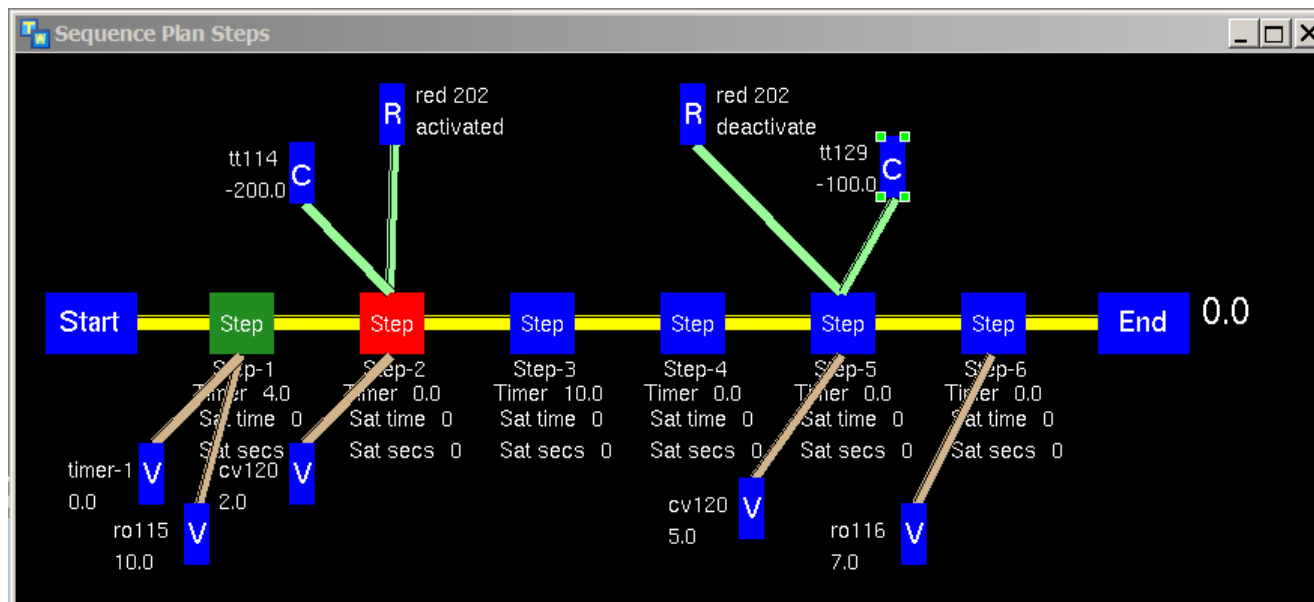
- System is designed in real time continuously
- Real time input data, monitoring with planned commanding and autonomous commanding as needed, manual commanding is also available

REPLAY

- Can run in Replay mode using historical data, commanding has a built-in simulator, speed of data can be controlled

Sequencer – Autonomous Commanding

- Sensor conditions, timers trigger next steps
- Command valves, pumps, cameras
- Red line conditions can trigger loading and execute shutdown or other plans



Create Plan

Create/Modify Sequence Plan - red line test

Current Sequence Plan

	Step Label	Trigger	Boolean	Condition	Timer	Valve	Set Point	CAM View
Step-1					4.0			
Step-1						TIMER-1	0.0	
Step-1						RO115	10.0	
Step-2		TT114	Less Than	-200.0				
Step-2					0.0			
Step-2						CV120	2.0	
Step-2		red 202-TT202-L-0.0-H-0.0					ACTIVATED	
Step-3					10.0			
Step-4	step-1:23:52				0.0			
Step-5		TT129	Less Than	-100.0				
Step-5					0.0			

Create Saturation Condition Red Line Activate/Deactivate Timer Update Step Label

Create Condition

TT174 Less Than 95.5 Add Step Condition

CURRENT CONDITIONS

	Trigger	Boolean	Condition
Step-2	TT114	Less Than	-200.0

SELECT CONDITION TO DELETE

TT114

Create Camera View

Add Device View

CHV109

View: Unknown

Delete View

SET VALVE/PUMP SETPOINTS/ACTIVATE TIMERS (no options)

CV120 2.0 ☐ Open ☐ Closed ☒ Variable Create Setpoint/Activate Timer

CURRENT SETPOINTS

	Valve/Pump	Setpoint
Step-2	CV120	2.0

SELECT SETPOINT TO DELETE

CV120

Save Plan Save Current Plan Load Plan Show Graphical Plan Delete Step Step-6 Clear Plan Delete Plan

Execute Plan

SEQUENCE PLAN CONTROL - test2

STEPS EXECUTED

	Step Label	Trigger	Boolean	Condition	Timer	Valve	Set Point	CAM View
Step-1						RO115	10.0	
Step-1						TIMER-1	0.0	
Step-1					4.0			

STATUS: PAUSED

☐ Simulator Commanding

START

RESET

PAUSE

RESUME

FORCE STEP ADVANCE

LOAD PLAN

ACTIVE STEP

COUNTDOWN TO ACTIVATE STEP: 0.0 Seconds

Simulator

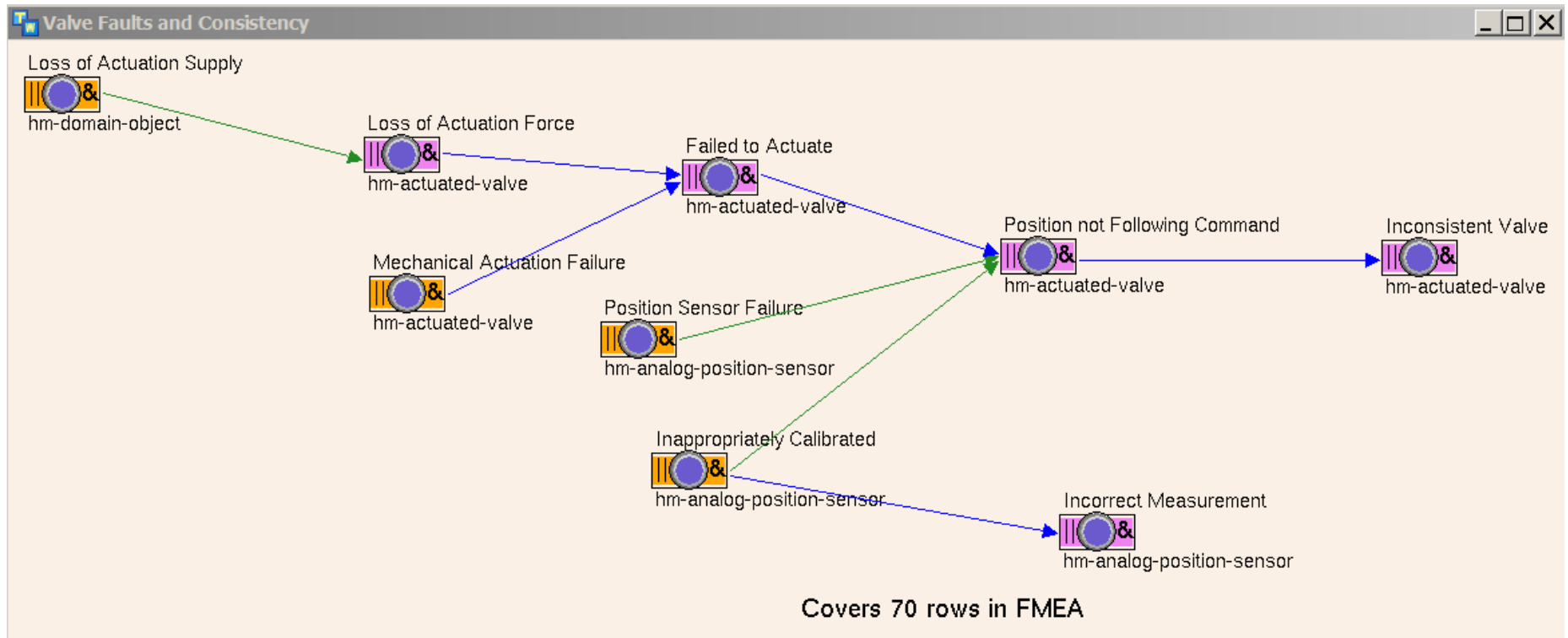
	Step Label	Trigger	Boolean	Condition	Timer	Valve	Set Point	CAM View
Step-2		TT114	Less Than	-200.0				
Step-2							CV120	2.0
Step-2		red 202-TT202-L-0.0-H-0.0					ACTIVATED	
Step-2					0.0			

FUTURE STEPS

	Step Label	Trigger	Boolean	Condition	Timer	Valve	Set Point	CAM View
Step-3					10.0			
Step-4	step-1.23.52				0.0			
Step-5		TT129	Less Than	-100.0				
Step-5					0.0			
Step-5						5.0	CV120	
Step-5		red 202-TT202-L-0.0-H-0.0					DEACTIVATE	
Step-6	step-1.23.52				0.0			
Step-6						7.0	RO116	

Fault Diagnosis

- We use Symcure Fault Trees to model the FMEA
- We have libraries of various fault trees



Monitors

Data Monitor Configuration [X]

☐ PT102
☐ PT104
☐ PT107
☐ PT109
☐ PT116
☐ PT122
☐ PT124
☐ PT126
☐ PT132
☐ PT138
☐ PT145
☒ **PT148**
☐ PT152
☐ PT161
☐ PT164
☐ PT173
☐ PT180
☐ PT183
☐ PT190
☐ PT193
☐ PT197
☐ PT198
☐ PT199
☐ PT207
☐ PT208
☐ PT209
☐ PT220

Start Hours: 0 Start Minutes: 0 Start Seconds: 0 Red Line: ☒
 End Hours: 0 End Minutes: 0 End Seconds: 0
 No Time Limit: ☒ Limits Color: blue
 STEP: None Found Line Color: green
 Maximum Value:
 Enabled: ☒ Setting: -200.000
 Condition: Enter High Red Line Condition Here.
 Minimum Value:
 Enabled: ☒ Settings: -250
 Condition: Enter Low Red Line Condition Here.

Save Changes Delete Next Create Current Monitor: 0
 Monitor Name: test monitor Total Monitors: 0

AL Monitors - SELECT STATUS TO MANUALLY ACTIVATE/DEACTIVATE --- SELECT PLAN TO SELECT LOAD PLAN OR SET TO NO PLAN

	Status	Plan Assigned - Red/Yellow if Red Line, White if Normal	Triggered	Time Activated	Start Hrs	Minutes	Seconds	End Hrs	Minutes	Seconds	Lower Limit Active	Lower Limit	Higher Limit Active	Higher Limit
PT183	Activated	No Plan	Not Triggered	No	0	0	0	0	0	0	Yes	10.0	Yes	20.0
PT148	Deactivate	C:\shh-nasa-toolkit\sequence-plans\red line test.kb	Not Triggered	No	0	0	0	0	0	0	Yes	-250.0	Yes	-200.0

Conclusions

- **Our toolkit can be used to implement autonomy capabilities in different application areas**
- **Build a model of domain using built-in classes**
- **Adapt data handling to fit application area**
- **Select diagnosis fault trees needed and adapt/build any new ones missing**
- **Customize User Interfaces for application**